PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

High Efficiency Engines and Turbines

12/2002

DEVELOPMENT OF LASER FLUORESCENCE AS A NON-DESTRUCTIVE INSPECTION TECHNIQUE FOR THERMAL BARRIER COATINGS

PRIMARY PROJECT PARTNER

University of Connecticut
Storrs, CT 06269

COST SHARING

$ 448,662

CUSTOMER SERVICE

800-553-7681

STRATEGIC CENTER FOR NATURAL GAS WEBSITE

www.netl.doe.gov/scng

Description

This Advanced Gas Turbine Systems Research (AGTSR) project builds on the success of an earlier AGTSR project that showed the feasibility of using laser fluorescence to reproducibly determine the stress in the thermally grown oxide on the bond coat of TBCs. Such localized stresses had been shown to be a major cause of spallation and failure of TBCs. The objective of the current project is to develop laser fluorescence as a non-destructive inspection (NDI) technique for TBC coated turbine parts.

Task 1 of the current project provides in-depth validation of the laser fluorescence technique on specimens with three different production TBC coatings that are thermally cycled. The remaining life will be determined as a function of measured stress using laser fluorescence. Task 2 will analyze specimens cycled to varying remaining life fractions to determine how micro-spalls initiate and explain the variation in stress with thermal cycles. Task 3 involves a laser fluorescence instrument maker Renishaw, Inc. in the modification and manufacture of a low-cost, portable instrument for use on turbine components. The final Task 4 demonstrates and validates the portable laser fluorescence instrument on as-coated and field service turbine blades and vanes from disassembled engines and assembled engines using fiber optics.

Figure 1 illustrates measured spectra from a laboratory instrument indicating a change in stress level for a TBC on a turbine part before and after service.

In addition to Renishaw as an instrument supplier, industrial partners in the project include turbine manufacturers (GE Power Systems, Honeywell, Pratt&Whitney, Rolls-Royce, Siemens Westinghouse, Solar Turbines), and a coating supplier (Howmet International).

Duration

36 months

Development of Laser Fluorescence as a Non-Destructive Inspection Technique for Thermal Barrier Coatings

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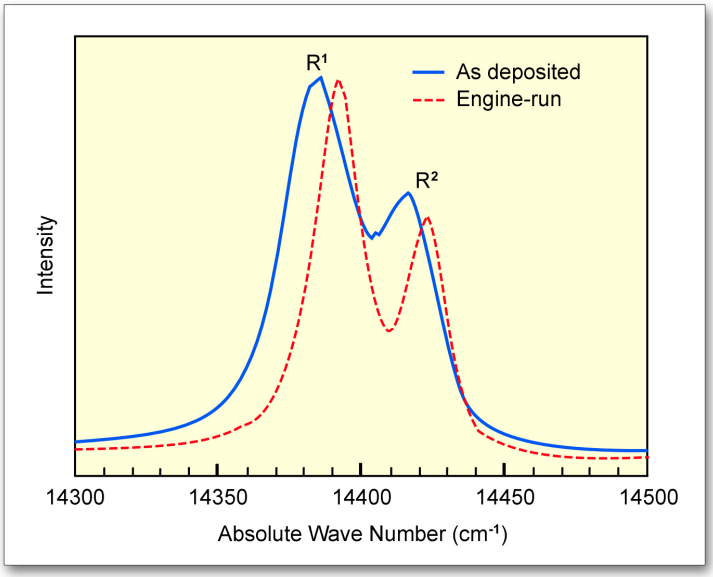

Figure 1. Stress Spectra for a TBC Before and After Engine Run

Goals

Non-destructive inspection (NDI) methods are needed to alleviate thermal barrier coating (TBC) manufacturing quality issues and operational lifetime inconsistencies. These have impeded the full implementation of the power and efficiency benefits of TBCs for industrial and utility turbines. Without an accurate measure of the expected coating life of a part, the variability of coating lifetimes has resulted in coating failures in the field or parts prematurely taken out of service if removed based on a conservative lower bound of expected coating lifetime. The goal of this project is to demonstrate and validate the laser fluorescence technique as a reliable, fast, and relatively low cost condition monitoring method for TBC coated turbine components.

Benefits

The need for a reliable NDI technique for TBCs is so great and the results from an earlier AGTSR project were so promising that several of the US gas turbine manufacturers, a coating supplier, and an instrument maker are actively involved in this current AGTSR project. One expected output from the project is a prototype of a low cost and portable NDI instrument for TBC's to be utilized by turbine manufacturers, overhaul facilities, and coating suppliers.